**Partnership for Science & Engineering Practices**

*Protocol for Unit Enhancement of Engineering Design Grades 6-8*

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**Part 1 Overview of Engineering Design in NGSS**

*Read the text below as a reminder of Engineering Design in grades 6-8.*

*Also examine the way that Engineering Design is present in the NGSS performance expectations.*

**Important Terminology and Text from Appendix I of NGSS**

**Technology:** *we broadly use the term “technology” to include all types of human-made systems and processes—not in the limited sense often used in schools that equates technology with modern computational and communications devices. Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants.*

**Engineering:** *We use the term “engineering” in a very broad sense to mean any engagement in a systematic practice of design to achieve solutions to particular human problems.*

**Science:** *is generally taken to mean the traditional natural sciences: physics, chemistry, biology, and (more recently) earth, space, and*

*environmental sciences*

**3 Components of Engineering Design:**

A. **Defining and delimiting engineering problems** involves stating the problem to be solved as clearly as possible in terms of criteria for success, and constraints or limits.

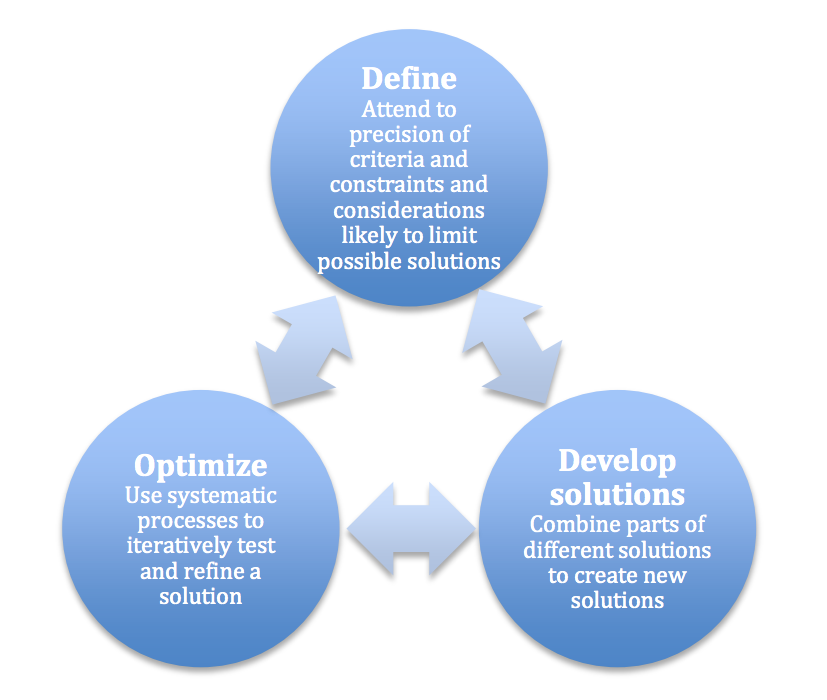
B. **Designing solutions to engineering problems** begins with generating a number of different possible solutions, then evaluating potential solutions to see which ones best meet the criteria and constraints of the problem.

C. **Optimizing the design solution** involves a process in which solutions are systematically tested and refined and the final design is improved by trading off less important features for those that are more important.

**Grades 6-8**

At the middle school level, students learn to sharpen the focus of problems by precisely specifying criteria and constraints of successful solutions, taking into account not only what needs the problem is intended to meet, but also the larger context within which the problem is

defined, including limits to possible solutions. Students can identify elements of different solutions and combine them to create new solutions. Students at this level are expected to use systematic methods to compare different solutions to see which best meet criteria and constraints, and to test and revise solutions a number of times in order to arrive at an optimal design.



**Engineering Design Content 6-8 (ETS)**

\_\_\_\_ **MS-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

\_\_\_ **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

\_\_\_ **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

**NGSS Performance Expectations with Engineering connections**

*(These are here as a reference so you can see how some NGSS Performance Expectations may contain integrated engineering practices)*

\_\_\_\_ MS-PS1-6 Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

\_\_\_\_ MS-PS2-1 Apply Newton’s Third Law to design a solution to a problem involving the motion of two colliding objects.

\_\_\_\_ MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

\_\_\_\_ MS-LS2-5 Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

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| **Part 2. Identify the High Leverage Lesson** |
| **Step 1:Examining your instructional material-**  **identify the authentic opportunities for engaging in Engineering Design.**   * Is there an existing Engineering task? (application task) * If so, how can you make the existing opportunity intentional and connect it to the Engineering Design process in the NGSS? * Is there an opportunity to add a new Engineering task? |
| **Step 2: Identify Science Concept**  Identify the science concepts (WA Science Standards) that students will use to engage with the Engineering task. |
| **Part 3. Clarify the Engineering Task** |
| **Step 1**: **Define the Problem**  ***MS-ETS1-1*** *Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.*   * *What is the problem or challenge that will guide the Engineering Design?*   + How can you make the problem more authentic?   + How might you provide opportunities for students to define and delimit the problem? * Define the Constraints (needs)   + Will you define constraints or will students?   + What materials will students use?   + What tools will students have?   + What time constraints? * Define the Criteria for Success (wants)   + Will you define criteria or will students? |
| Problem:  Constraints:  Criteria: |
| **Step 2**: **Develop Solutions**  **MS-ETS1-2** Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.   * What research might students need to do? * What resources might they need? * What solutions might students brainstorm? * How will students decide which solutions to test? |
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| **Step 3**: **Optimize Solutions**  **MS-ETS1-3** Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.   * How will students test their solution? * What opportunities will students have to improve their solution? |
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| **Part 4. Determine the Assessment Task** |
| **Step 1: Identify Assessment Target**   * What part(s) of Engineering Design will you assess? |
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| **Step 2: Evidence of Learning**   * What evidence of student learning will you collect? |
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| **Step 3: Success Criteria**   * What criteria will you use to assess the learning? |
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| **Step 4: Supports**   * What scaffolds and supporting documents might students need? |
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| **Part 5: Plan the Learning Sequence** |
| **Step 1: Identify the Learning Sequence**  Use some of the strategies below to create a Learning Sequence.  How will you:   * Introduce the Engineering Design Process * Set expectations for collaborative group work * Connect to authentic everyday examples of engineering * Provide feedback to students on their solutions |
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| **Step 2**: **Identify Tools and Strategies**   * What strategies and activities might you use to intentionally teach students about Engineering Design so they will be successful on the Assessment Task in Part 4? |
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| **Step 3: Supporting All Learners** How can we tailor instruction to students who may have special needs, interests, and abilities?  *(Engineering can create strong engagement that is particularly important for students who have traditionally not considered science as a possible career choice, including females and students from multiple languages and cultures in this global community)* |
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| **Step 5: Additional Notes and Resources**  What additional information do you want to make sure and remember when you are ready to teach these lessons?  What other resources might be useful for supporting teachers and/or learners during these lessons? |
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